CONFERENCE OF THE EIGHTEEN-NATION COMMITTEE ON DISARMAMENT

ENDC/154
2 September 1965
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SWEDEN

Memorandum on international co-operation for the detection of underground nuclear explosions

In view of the efforts being made to extend the partial test ban to cover also underground nuclear tests, the question of improving existing facilities for monitoring seismic events has received increased attention. The scientific advisers, attached to the Swedish delegation at the ENDC, a few months ago presented a discussion paper on extended international co-operation in seismology for detection purposes ("detection club"). The Swedish delegation has the honour to present to the ENDC for information its views on this subject.

Underground nuclear explosions do not, as a rule, generate global distributions of easily detected radio active debris. So far the seismic method seems to be the only technical way to detect them. Since the conclusion of the partial test ban considerable progress has been made in the fields of seismic detection. Problems, however, still remain in the fields of identification and inspection. These problems are not discussed in this paper which is confined to the problem of detection, i.e. questions related to the national systems of seismological detection.

The seismological stations are not yet optimally developed in all countries. It is surmised that if the means of detection were sufficiently developed, the problem of identification, i.e. of distinguishing between natural earthquakes and man-made explosions would be greatly facilitated.

Well equipped and well located stations can now detect events corresponding to yields of the order of one kiloton from distances up to 10.000 kilometres, covering half the globe. Hence no state has territories large enough to contain such seismic signals within its borders. The methods to record these signals seems now to be good enough to permit an adequate "national means only" solution of the detection part of the verification problem. If, however, the data emanating from the national systems were kept insulated within the national framework of each country, few of these, if any, would be large enough to monitor signals from the whole globe. To make it possible for all nations, interested in the compliance with a treaty banning

nuclear test explosions, to follow and also seek to evaluate events, presupposes availability of data from several stations in widely distributed and suitably selected locations. Such co-operation by exchange of seismological data is already internationally instituted for the purpose of monitoring and studying earthquakes.

As new and technologically much more advanced seismic stations are now being established and data flowing from them are beginning to reach the community of scientists in this field, the time has come to consider which forms further collaboration should take. We think that states, interested on one hand in furthering seismological observations and research and on the other hand in the detection of underground explosions, will find it useful to co-operate in an exchange of pertinent seismological observations. Such a "detection club" would essentially be an international data service, giving access to first class data for independent analysis.

If such co-operation is started before an underground test ban enters into force, research on the remaining test ban verification problems will be facilitated.

The last mentioned aspect has led the Swedish Government to plan certain steps to establish in Sweden appropriate resources for seismological observation and analysis. The observation data will be made available to all interested parties, and Sweden expects to get corresponding information in return.

The detection club data should preferably come from good instruments on good sites, globally distributed in advantageous positions. Although a broad participation would be desirable, such a global network could be based on seismological observations from selected stations in a rather small number of countries.

In order to broaden the uncertainty range of the absolute detection threshold facing a prospective test ban violator and thus increase the deterrence capability of seismological verification systems it is foreseen that some stations might remain outside the network of co-operating stations.

The data exchanged should comprise short messages - of the bulletin type currently used by seismologists - continuously circulated on a time scale appropriate to detection efforts. It would also be of great value if the results of calculations on bulletin data were included. The data co-operation should, furthermore, comprise the exchange, upon request, of copies of records.

Another essential element of the proposed co-operation would be the facilitation of the data exchange by the adoption of appropriate standards for instrumentation and data formats.

One will also have to consider that the existing and projected advanced seismological stations will extract a very large amount of information from the earth. To cope with this immense quantity of data it may prove necessary to establish some international co-ordinating body.

International data exchange is since long a well established practice in the geophysical sciences. The paramount importance of such co-operation for seismology has generated several national, regionally international and global schemes for the collection, analysis and exchange of data. Examples of regionally international schemes are the arrangements maintained in France, Japan, the USSR and the United States,

Indeed, much of the desiderata for the extended data exchange proposed in this paper is already met by the existing arrangements for scientific purposes. Thus, the specific needs of a "detection club" would in many cases require only adjustments of present national and international efforts.

The development of the science of geophysics and of the technique of test ban verification are closely connected. It would therefore be advantageous for all concerned to make the "detection club" data available to all scientists, to use such standards as might be sponsored by the International Council of Scientific Unions, to seek ways to achieve rapid circulation of bulletin data on some global telecommunication network accessible to scientists (e.g. the one used by the World Metereological Organization for weather data and tapped in all countries) and to achieve co-ordination as far as possible, with existing global seismological co-operative efforts, such as the International Seismological Centre at Edinburgh.

The considerations in this paper have been formulated so as to help achieve more effective seismological detection as well as to allow science to benefit from resources allocated for detection purposes and vice versa, while avoiding to place an unwanted politcal burden upon scientists.

CONFERENCE OF THE EIGHTEEN-NATION COMMITTEE ON DISARMAMENT

ENDC/155
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UNITED KINGDOM

Notes on United Kingdom Research on techniques for distinguishing between earthquakes and underground explosions

The E.N.D.C. is familiar with the history of the Experts Conference here in Geneva in 1958 and its recommendations for monitoring possible violations of a nuclear test ban treaty in all environments. Then, as now, discussions about how to distinguish between earthquakes and man-made underground explosions proved most difficult of all. This continuing difficulty is reflected in the fact that while it is still not possible to obtain agreement on this problem, a treaty banning nuclear tests in all other environments has been concluded.

When it became clear that for various reasons the control system recommended at Geneva in 1958 was unlikely to be implemented, scientists in the United Kingdom took a new look at the possibilities of detecting underground events at much greater distances than the 1000 kilometre range required for the Geneva recommendations of 1958. The thought was that seismic waves generated at such distances as would enable them to travel through the earth's homogeneous deep mantle should be much freer from the complexities introduced at shorter ranges by heterogeneities along shallower propagation paths through the earth's crust. With this concept in mind, U.K. scientists embarked on a seismic research programme to examine the possibilities of developing a detection system very different from that already recommended at Geneva.

The problem was seen as calling not only for research in all the usual seismic conditions but also as one where the seismic problem itself should be examined as one of exact measurement. The latter aspect immediately led to all recordings being made in such a way as would enable them to be processed electronically. By increasing the number of seismometers per station and deploying them in beam-forming arrays, by placing them in deep boreholes and by seeking lower noise sites than previously used,

the possibility of great improvements in the signal to noise ratio soon became apparent with an essentially increased ability to see the first motions of the compressional or P waves arriving from a seismic source.

It was found that arrays of this particular type offered the greatest promise of advancement. As well as offering a signal to noise improvement in proportion to the square root of the number of seismometers used, they allowed the possibility of turning the array to more than one signal component velocity, thus improving the reception of later signal components, they offered an approximate determination of the direction of the source and they provided a body of data which enabled a method for determining depth of focus to be applied with considerable success. With such early encouragement scientists in the U.K. intensified their work with these arrays and established an experimental facility in U.K. to develop array techniques and prove instrumentation. At the same time, in close collaboration with their colleagues in the U.S., they established a similar experimental facility in the U.S. From this work it became apparent that a completely new concept of methods could be used to detect and identify earthquakes. The main facts then emerging may be summarised as follows:

(a) Application of data processing techniques to magnetic tape recordings increased the capability of determining first motion of the first wave.

(b) Estimation of the focal depth of events could be improved.

(c) Array type stations could be operated effectively beyond 3000 kilometres, as compared with the 1000 kilometres range for the previous Geneva system.

(d) Comparative differences in the characteristics of seismic waves from earthquakes and explosions were enhanced.

These advances suggested that the seismic detection and identification required to monitor a ban on underground tests could be carried out by a relatively small number of array stations at teleseismic distances. The reduced number of station sites in turn increased the possibility of confining stations to the quietest seismic sites available and this in itself led to a significant improvement in attaining the signal to noise ratio necessary to detect the smallest events of interest.

The next stage in this research work obviously called for a specific study of explosions and earthquakes at teleseismic distances using large arrays. In the U.K.

case these have varied from about 10 to 25 kilometres in length, are of a crossed linear geometry rather than triangular or radial and are carefully sited for noise, interference, and topographical characteristics. This phase of the work is a continuing part of the research programme still being pursued by U.K. scientists.

In the development and application of these array systems there are many variants to be examined. These include array geometry, site noise level, the number and characteristics of seismometers to be deployed. The results to be reported from the very large array experiment now being carried out in the United States will be of great interest. It is hoped that the approach taken by U.K. scientists will also contribute to resolving this difficult problem of distinguishing between natural seismic events and man-made underground explosions. A corresponding statement from any other delegation which has a contribution to report would be welcome. But behind all this, many detailed technical problems arise calling for detailed technical discussion. It would therefore be greatly preferable to have the scientists working on these problems brought together to discuss their work and assess the possibilities of creating an effective monitoring system for the detection and identification of underground nuclear explosions. It may well be that an effective monitoring system will call not for one particular type of array but various types depending on local seismic and topographical characteristics, as well as costs.

In the meantime the U.K. has continually sought to exploit these new technical advances as they have come along. They made possible a new approach to an underground test ban in 1962 and the West have continued to modify their position as scientific evidence has accumulated. Some of this work has already been published and all the work carried out by U.K. scientists is now being prepared for publication. That work was the subject of a symposium sponsored by the Royal Society in January of this year and to which representatives from many countries, including the Soviet Union, were invited.

Nevertheless, with all these technical advances there still remains a residual number of seismic events at or above seismic magnitude 4.0 that would be unidentifiable by remote seismological observations alone, and which could be suspected as possible violations of a test ban, unless they could be eliminat d by some supplementary means such as on-site inspection being applied in some measure. This is the

problem that still confronts us and that prevents an extension of the test ban treaty to cover the underground environment. It remains to be seen whether further research can provide any significant improvement on the position now reached but if there is such a possibility the U.K. believe that it could only be hastened in a detailed joint examination of the advances now achieved in the Soviet Union, the United States and the United Kingdom.

CONFERENCE OF THE EIGHTEEN-NATION COMMITTEE ON DISARMAMENT

PRIVATE
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RUSSIAN

DRAFT
REPORT TO THE UNITED NATIONS DISARMAMENT COMMISSION AND THE GENERAL ASSEMBLY
(recommended by the co-Chairmen)

The Conference of the Eighteen Nation Committee on Disarmament transmits to the United Nations Disarmament Commission and to the General Assembly, a report on the Committee's deliberations on all questions before it for the period 27 July 1965 to 16 September 1965.

Representatives of the following States continued their participation in the work of the Committee:

Brazil, Bulgaria, Burma, Canada, Czechoslovakia, Ethiopia, India, Italy, Mexico, Nigeria, Poland, Romania, Sweden, the Union of Soviet Socialist Republics, the United Arab Republic, the United Kingdom of Great Britain and Northern Ireland, and the United States of America.

I. Procedural Arrangements

A. Upon recommendation of the Co-Chairmen, members of the Committee reconvened the Conference on 27 July 1965.

B. Sixteen plenary meetings took place between 27 July 1965 and 16 September 1965.

C. The Committee at its _____ meeting on _____ September 1965, having in view the convening of the Twentieth Session of the General Assembly on 21 September 1965, decided to adjourn this session of the Conference following its plenary meeting on 16 September 1965. The Committee decided to resume its meetings in Geneva as soon as possible after the termination of the consideration of disarmament at the Twentieth Session of the General Assembly, on a date to be decided by the two Co-Chairmen after consultation with the members of the Committee.

II. General and Complete Disarmament

Members of the Committee have continued discussion of general and complete disarmament in meetings of the Committee. The Committee considers it to be a primary goal of its future work to continue efforts to develop a treaty on general and complete disarmament under effective international control. However, in view of present international developments, a number of members concentrated their attention at this session of the Conference on collateral measures.

III. Measures Aimed at the Lessening of International Tension, the Consolidation of Confidence Among States, and Facilitating General and Complete Disarmament

The Committee, in its efforts to achieve and implement the widest possible agreement at the earliest possible date, continued consideration in its plenary meetings of such measures as could be agreed to prior to, and as would facilitate the achievement of, general and complete disarmament.

On 26 July 1965 the Co-chairmen received a letter (ENDC/149) from the Chairman of the Disarmament Commission transmitting to the Committee document DC/224, addressed to the United Nations General Assembly and containing the text of the resolution adopted by the Disarmament Commission on 12 June 1965 on the question of a world disarmament conference, and document DC/225, containing the text of the resolution adopted by the Disarmament Commission on 15 June 1965 which made certain specific recommendations to the Committee.

On 27 July 1965, at the 218th meeting, the United States submitted a message from President Lyndon B. Johnson to the Conference of the Eighteen-Nation Committee on Disarmament (ENDC/150).

On 29 July 1965, at the 219th meeting, the United Kingdom representative read a message to the Conference from Prime Minister Harold Wilson.

On 5 August 1965, at the 221st meeting, the Committee issued a statement on the second anniversary of the signing of the limited test ban treaty in Moscow which stated that the Committee considered more urgent than ever further progress on disarmament measures.

On 10 August 1965 a letter was submitted by the Union of Soviet Socialist Republics representative to the Special Representative of the Secretary General of the United Nations (ENDC/151).

On 17 August 1965, at the 224th meeting, the United States, supported by the delegations of Canada, Italy, and the United Kingdom, submitted a draft treaty to prevent the spread of nuclear weapons (ENDC/152)* and a statement by President Lyndon B. Johnson on this draft treaty (ENDC/153).

On 2 September 1965, at the 229th meeting, Sweden submitted a memorandum on international co-operation for the detection of underground explosions (ENDC/154)*.

On 9 September 1965, at the 231st meeting, the United Kingdom submitted notes on United Kingdom research on techniques for distinguishing between earthquakes and underground explosions (ENDC/155)*.

[References to possible additional memoranda or documents would be made at this point in the report]

As at past sessions, the questions before the Committee were in general discussed in a thorough manner. All the participants in the Committee took an active part in this discussion, and a number of interesting suggestions were put forward. The Soviet Union stated its readiness to meet the position taken by the United Arab Republic and to agree to its proposal that the implementation of the Moscow Treaty relating to the banning of tests of nuclear weapons in the atmosphere, in outer space and under water should be extended to cover under-ground nuclear tests above a seismic magnitude of 4.75, and that as an additional measure the nuclear Powers should agree to a moratorium on all other forms of under-ground nuclear testing until such time as agreement had been reached on an overall ban on nuclear weapons tests. The United States reiterated its readiness to conclude an adequately verified comprehensive test ban treaty and in this regard emphasized the desirability of an exchange of scientific information among nuclear powers as suggested by the eight non-aligned states in document ENDC/145.

The Committee did not reach any specific agreement at this session either on questions of general and complete disarmament or on measures aimed at the lessening of international tension. However, the members of the Committee believe that the

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* Indicates Conference documents which are attached at Annex 1.

extensive discussions on major problems relating to certain collateral measures were particularly valuable in clarifying the respective points of views of member governments. The Committee believes that these discussions and exchanges of views may facilitate agreement in the further work of the Committee.

IV. Meetings of the Co-chairmen

During the period covered by this report, the Representatives of the Union of Soviet Socialist Republics and of the United States of America, in their capacity as Co-Chairmen of the Eighteen-Nation Committee on Disarmament, held meetings to discuss the schedule of and procedure for the work of the Conference and certain substantive questions before the Conference.

V. Conference Documents

Transmitted as Annex II to this report is a list of all documents and verbatim records of the plenary meetings.

This report is submitted by the Co-chairmen on behalf of the Conference of the Eighteen-Nation Committee on Disarmament.

Union of Soviet Socialist Republics

S. K. Tsarapkin

United States of America

William C. Foster